BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

F/104 L64 KR

(1)

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
H01M 2/26, 6/10, 10/28, 2/10

A1

(11) International Publication Number: **WO 99/36979**

(43) International Publication Date: 22 July 1999 (22.07.99)

(21) International Application Number: PCT/US99/00986

(22) International Filing Date: 18 January 1999 (18.01.99)

(30) Priority Data:

60/071,786	19 January 1998 (19.01.98)	US
09/205,915	4 December 1998 (04.12.98)	US

(71) Applicant: JOHNSON CONTROLS TECHNOLOGY COMPANY [US/US]; 49200 Halyard Drive, Plymouth, MI 48170 (US).

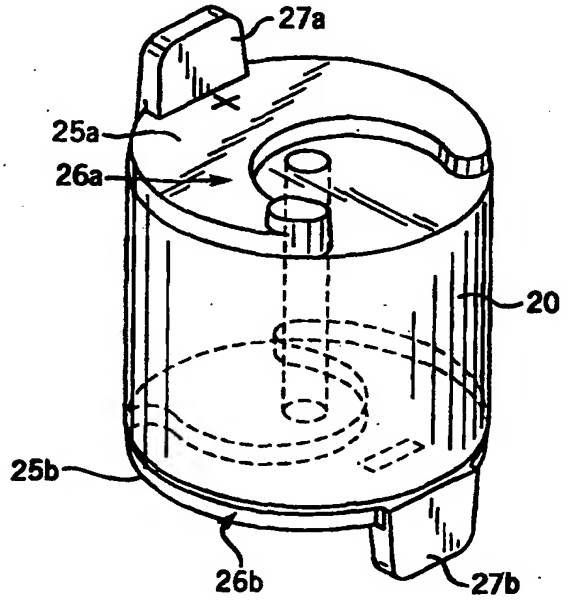
(72) Inventors: ANDREW, Michael, G.; W134 N6596 Lilly Creek Drive, Menomonee Falls, WI 53051 (US). DOUGHERTY, Thomas, J.; 3005 Mesa Verde Drive, Waukesha, WI 53188 (US). ZAGRODNIK, Jeffrey, P.; 6260 Whitnall Way, Hales Corners, WI 53130 (US).

(74) Agent: RYSER, David, G.; Quarles & Brady LLP, 411 East Wisconsin Avenue, Milwaukee, WI 53202–4497 (US).

(81) Designated States: BR, CA, CN, IN, JP, MX, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: STRAP FOR SPIRALLY WOUND THIN METAL FILM BATTERY



(57) Abstract

A thin metal film battery cell is formed by one or more plates wound in a spiral thereby forming a roll with two ends at which spiralled edges of the plates are exposed. Each end of the roll is covered by an end strap which includes a body of electrically conductive material from which a tab extends. The body contacts each convolution of the roll while leaving a portion of each convolution exposed so that an electrolyte is able to flow into the roll. The tab attached to and projecting outward from the body for making electrical connection to the thin metal film battery cell.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

STRAP FOR SPIRALLY WOUND THIN METAL FILM BATTERY

Background of the Invention

This invention relates to electric storage batteries and more particularly to a termination strap for thin metal film battery cells.

A thin metal film battery cell includes plates made from very thin lead foil pasted with an active material on both surfaces. Plates with positive active material and plates with negative active material are separated by a separator strip and are spirally wound to form a roll. Unpasted edges of the positive plates extend in one direction while unpasted edges of the negative plates extend in an opposite direction from the roll. Terminations of lead or lead alloy are cast on or soldered to the ends of the spiral roll. U.S. Patent No. 5,198,313 issued March 30, 1993, for "Battery End Connector" describes one arrangement of cast-on end connectors for the two ends of a spiral roll.

The present invention provides a termination for a thin metal film roll in the form of a cap-like strap which uses less lead than the terminations of the prior art and which facilitates improved exposure of each of the spiral layers, or convolutions, to electrolyte. The strap also facilitates high voltage extrusion welding of the straps of adjacent cells.

Summary of the Invention

In accordance with the invention, a cap-like strap is formed at an end of a spirally wound cell of alternating convoluted layers of positive and negative thin metal foil plates. The shapes of the straps are is characterized by the fact that the strap engages a portion of the projecting ends of each layer of the spiral, while leaving another portion of the projecting ends of each layer exposed. The strap is further characterized by an upstanding, integrally formed tombstone portion for connection to adjacent cells or to a terminal. A strap having the foregoing characteristics is formed at each end of the spiral roll.

The strap can take a variety of configurations and is preferably cast in place on the end of the spiral roll.

The foregoing and other objects and advantages of the invention will appear in the detailed description which follows. In the description, reference is made to the accompanying drawings which illustrate preferred embodiments of the invention.

Brief Description of the Drawings

Figure 1 is an exploded view in perspective of a battery using the straps of the present invention;

Figure 2 is a top view of the battery of Figure 1 with a top removed;

Figure 3 is a bottom view of the battery of Figure 1 with a bottom removed;

Figure 4 is a perspective view of a battery cell with the straps of the present invention; and

Figures 5-9 are plan views of alternative shapes for the strap of the present invention.

Detailed Description of the Preferred Embodiments

The basic battery construction shown in the drawings is the subject of a co-pending U.S. patent application Serial No. 09/008,719 filed January 19, 1998. The disclosure of the co-pending application is incorporated herein by reference as though fully set forth herein.

Briefly, the battery illustrated in the drawings includes a case having a body 12 with a top 14 and a bottom 16 each joined to the body 12 in a manner known in the art, such as by heat sealing. The case is configured to accommodate a plurality of thin metal film cells 18 that include a spirally wound thin metal film roll 20 coiled in a manner generally known in the art. That is, thin lead foil plates coated with positive or negative active material are spirally wound with a separator layer between the plates. The positive and negative plates are wound axially off-set from each other so that the edges of the positive plate protrude axially from one end and the edges of the negative plate protrude axially from the other end.

As thin metal film battery cells are generally known in the art, recognized techniques for manufacturing such cells and the manner in which they generate electricity will not be described herein. For a general description of such cells, reference may be had to U.S. Patent Application No. 08/870,803, filed June 6, 1997, entitled "Modular Electric Storage Battery", and assigned to the assignee of the present invention. The disclosure of such earlier filed application is incorporated herein by reference.

Each end of the spirally wound roll of plates and separator is joined to a cap-like strap 26a and 26b fabricated of lead which is cast in place and connects the projecting edges of one of the positive or negative plates. As shown in Figure 1, the straps 26 are configured in such a manner that they connect with all convolutions of the spirally wound roll but also expose an axial end portion of

each spiral convolution. The result is that an electrical connection is established to the positive or negative plates while at the same time allowing electrolyte to pass axially into each convoluted layer of the roll. Each strap 26a and 26b has a flat body 25a and 25b, respectively, from which extend an integral tombstone portion forming a tab 27a and 27b, respectively. As shown in Figure 3, the tabs 27a and 27b on certain of the straps on opposite ends of the roll 20 are off-set by 180°. On other rolls 20, the tabs are off-set by 90°.

The cells 18 are received in a honeycomb structure formed in the body 12. As shown in Figures 2 and 3, the positive and negative straps are arranged in the honeycomb case in such a manner that they can be serially connected to each other by welding in a known manner and also can connect to terminals 30 and 32. In Figures 2 and 3, the two cells 18c and 18d that are remote from the terminals 30 and 32 have their tabs offset by 90°. The remaining cells 18a, 18b, 18e, and 18f have the tabs offset by 180°.

As shown in Figures 1-4, the preferred form of the cap-like strap utilizes a crescent shape with the opening of the crescent off-set from the centerline of the roll. Alternative strap configurations are shown in Figures 5-9. All of the shapes of the straps are characterized by the fact that the strap engages a portion of the projecting ends of each convolution of the spiral, while leaving another portion of the projecting ends of each convolution exposed. Each of the configurations also includes an upstanding tombstone tab for making electrical connections between adjacent cells and external terminals on the battery.

Electrolyte is introduced into the battery through vents 34 in the top 14 that are centered over each cell. The cap-like strap of this invention allows the electrolyte to readily wet all the convoluted layers.

CLAIMS

We claim:

1. An end strap for a thin metal film battery cell formed by a plate which is wound in a spiral thereby forming a roll with two ends at which spiralled edges of the plate are exposed, the end strap comprising:

a body of electrically conductive material for abutting one end of the roll wherein the body contacts each convolution of the roll while leaving a portion of each convolution exposed so that an electrolyte is able to flow into each convolution of the roll; and

a tab of electrically conductive material attached to and projecting outward from the body for making electical connection to the thin metal film battery cell.

2. The end strap as recited in claim 1 wherein the body has two major surfaces and at least one edge surface extending between the two major surfaces; and the tab projecting from one of the two major surfaces.

3. The end strap as recited in claim 1 wherein the body has two major surfaces and at least one edge surface extending between the two major surfaces; and the tab projecting from one of the two major surfaces at a location adjecent to the at least one edge surface .

4. The end strap as recited in claim 1 wherein the body has a crescent shape.

5. The end strap as recited in claim 1 wherein the body has a semicircular shape.

6. The end strap as recited in claim 1 wherein the body has a trapezoidal shape.

7. A battery cell comprising:

a roll formed by first and second thin metal foil plates wound in a spiral with a spiral edge of the first thin metal foil plate protruding from a first end of the roll and a spiral edge of the second thin metal foil plate protruding from a second end of the roll;

a first strap abutting the first end of the roll and including a first body of electrically conductive material contacting each convolution of the first thin metal foil plate while leaving a portion of each convolution first thin metal foil plate exposed so that an electrolyte is able to flow into the roll, and a first tab of electrically conductive material attached to and projecting outward from the first body for making electrical connection to the thin metal film battery cell; and

a second strap abutting the second end of the roll and including a second body of electrically conductive material contacting each convolution of the second thin metal foil plate while leaving a portion of each convolution second thin metal foil plate exposed so that the electrolyte is able to flow into the roll, and a second tab of electrically conductive material attached to and projecting outward from the second body for making electrical connection to the thin metal film battery cell.

8. The battery cell as recited in claim 7 wherein the first tab is off-set from the second tab by 180°.

9. The battery cell as recited in claim 7 wherein the first tab is off-set from the second tab by 90°.

10. The battery cell as recited in claim 7 wherein each of the first body and the second body has two major surfaces and at least one edge surface extending between the two major surfaces; and a respective one of the first tab and the second tab projects from one of the two major surfaces.

11. The battery cell as recited in claim 7 wherein each of the first body and the second body has two major surfaces and at least one edge surface extending between the two major surfaces; and a respective one of the first tab and the second tab projects from one of the two major surfaces at a location adjecent to the at least one edge surface.

12. The battery cell as recited in claim 7 wherein the first and second bodies each have a crescent shape.

13. The battery cell as recited in claim 7 wherein the first and second bodies each have a semicircular shape.

14. The battery cell as recited in claim 7 wherein the first and second bodies each have a trapezoidal shape.

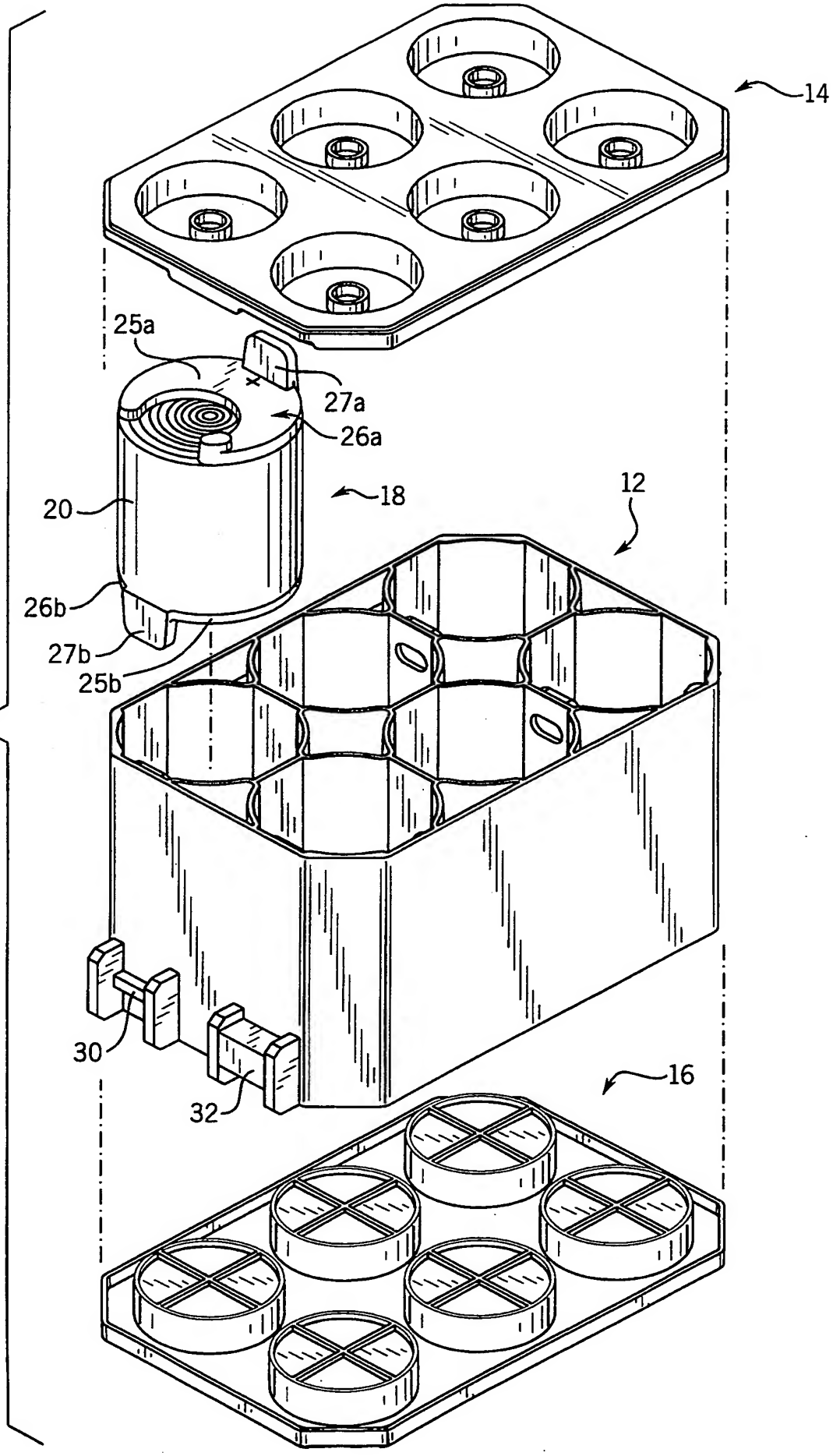


FIG. 1

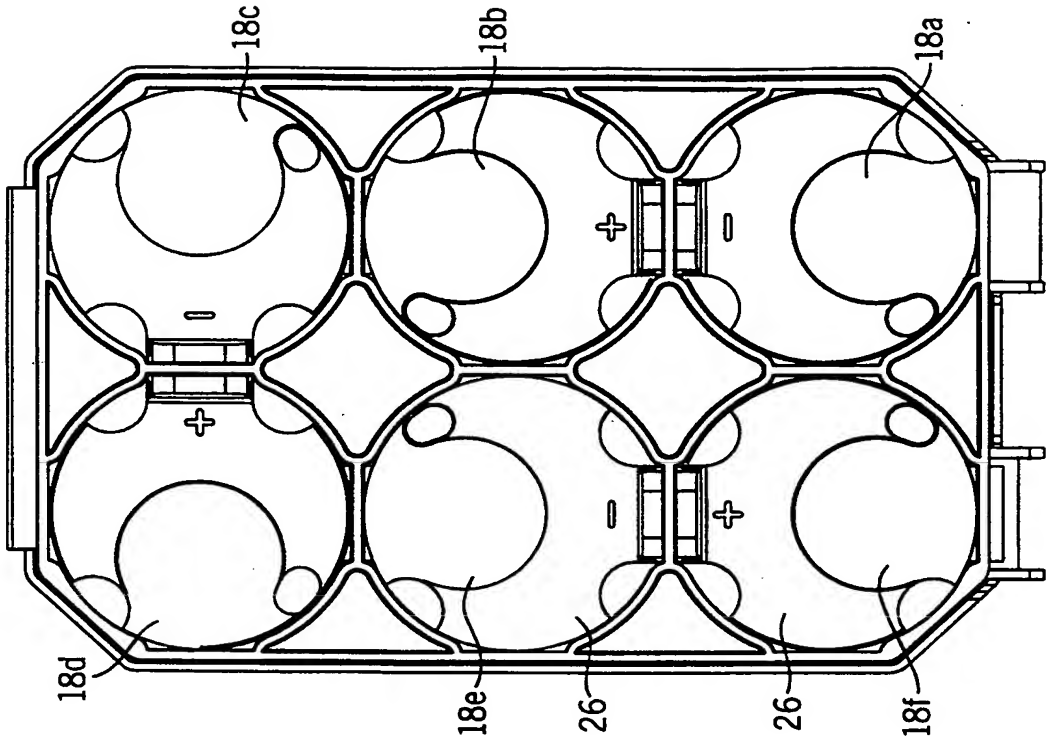


FIG. 3

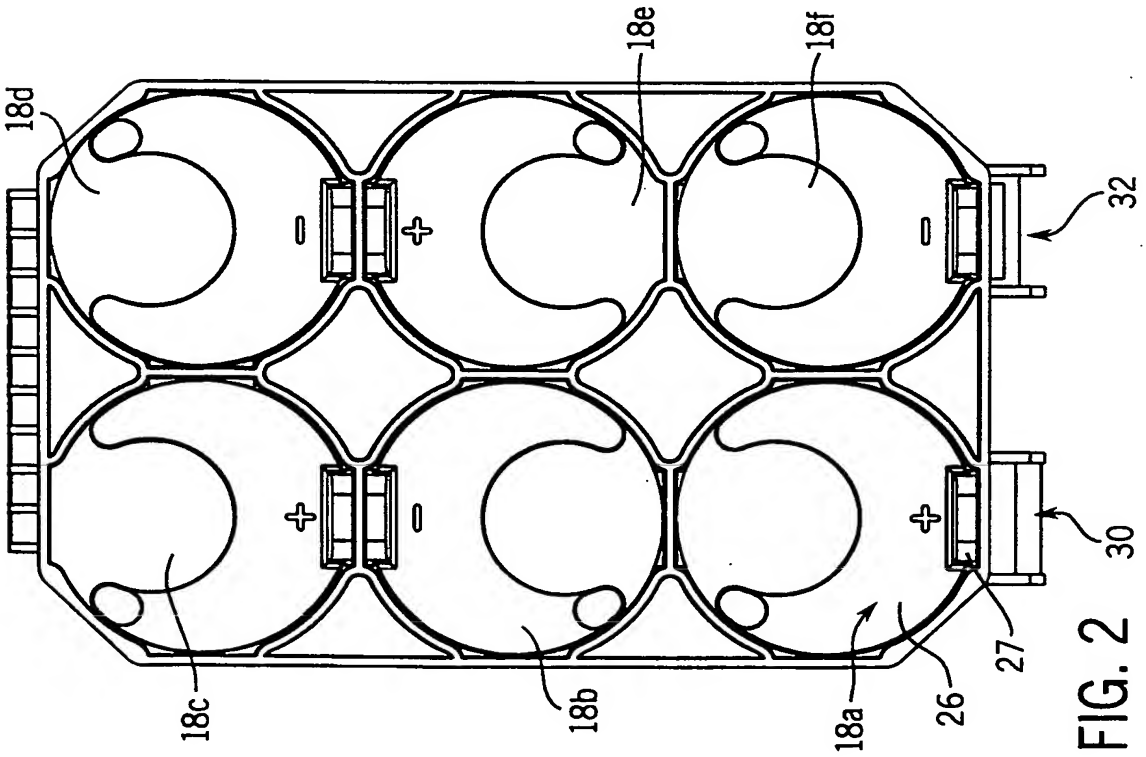


FIG. 2

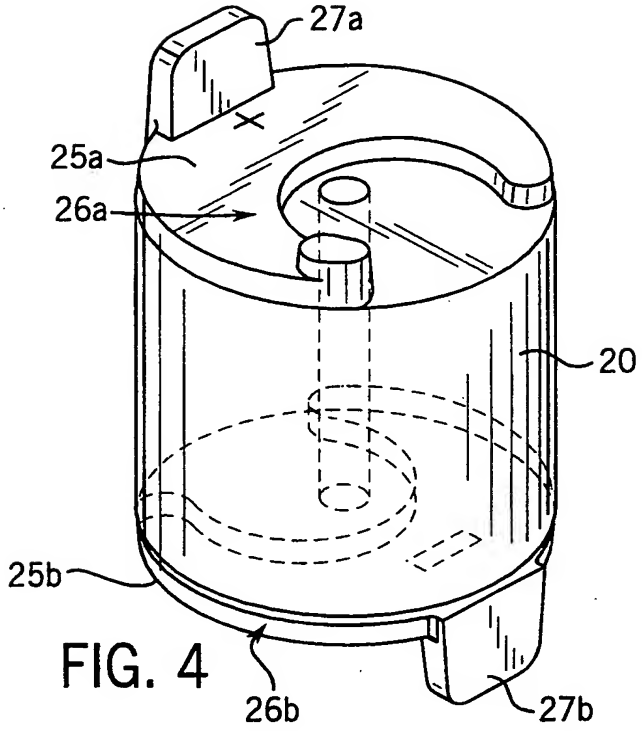


FIG. 4

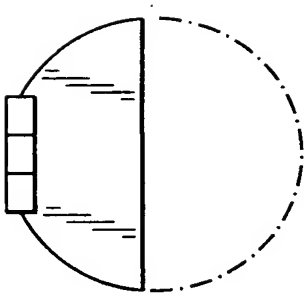


FIG. 5

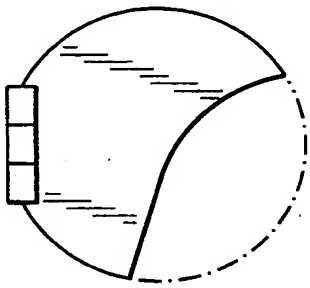


FIG. 6

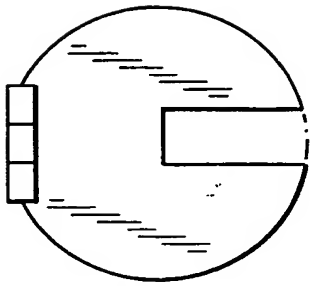


FIG. 7

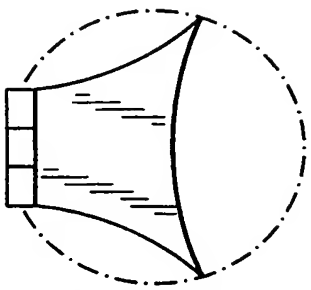


FIG. 8

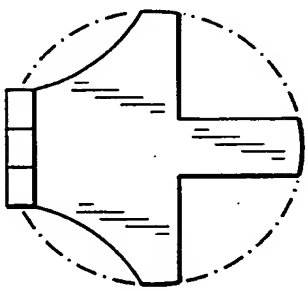


FIG. 9

INTERNATIONAL SEARCH REPORT

Ir ational Application No
PCT/US 99/00986

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01M2/26 H01M6/10 H01M10/28 H01M2/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	EP 0 545 906 A (MATSUSHITA ELECTRIC IND CO LTD) 9 June 1993 see column 3, line 49 - column 4, line 36 see figures 2-4	1-3,5 7,10,11, 13
X Y	PATENT ABSTRACTS OF JAPAN vol. 009, no. 178 (E-330), 23 July 1985 & JP 60 049558 A (MATSUSHITA DENKI SANGYO KK), 18 March 1985 see abstract	1-3 7
X Y	PATENT ABSTRACTS OF JAPAN vol. 009, no. 178 (E-330), 23 July 1985 & JP 60 049560 A (MATSUSHITA DENKI SANGYO KK), 18 March 1985 see abstract	1-3 7

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents. such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 April 1999	10/05/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Engl, H

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/00986

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 006, no. 119 (E-116), 3 July 1982 & JP 57 046468 A (JAPAN STORAGE BATTERY CO LTD), 16 March 1982 see abstract	1
X	US 3 960 603 A (DEJIMA SHIGEO ET AL) 1 June 1976	1-3,5
Y	see column 2, line 24-65 see figure 3	7,13
X	US 3 732 124 A (CAILLEY J) 8 May 1973 see column 3, line 3-32 see figure 2	1-3
Y	US 5 198 313 A (JUERGENS TRISTAN E) 30 March 1993 cited in the application see column 2, line 42 - column 3, line 5 see column 5, line 16-59	7-14
Y	US 5 599 641 A (CHING JR LARRY K W ET AL) 4 February 1997 see figure 2 see column 3, line 53 - column 4, line 45	7-14

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

In: ıtional Application No
PCT/US 99/00986

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0545906 A	09-06-1993	JP 2762599 B	04-06-1998
		JP 3078964 A	04-04-1991
		DE 68917593 D	22-09-1994
		DE 68917593 T	05-01-1995
		DE 68925431 D	22-02-1996
		DE 68925431 T	30-05-1996
		EP 0413867 A	27-02-1991
		US 5006426 A	09-04-1991
US 3960603 A	01-06-1976	JP 1046202 C	28-05-1981
		JP 51063440 A	01-06-1976
		JP 55037827 B	30-09-1980
		JP 1085236 C	25-02-1982
		JP 50134151 A	24-10-1975
		JP 54031575 B	08-10-1979
		DE 2516530 A	30-10-1975
		GB 1451302 A	29-09-1976
US 3732124 A	08-05-1973	FR 2097301 A	03-03-1972
US 5198313 A	30-03-1993	US 5047300 A	10-09-1991
		AT 175293 T	15-01-1999
		AU 667196 B	14-03-1996
		AU 2597392 A	05-04-1993
		CA 2118705 A	18-03-1993
		DE 69228076 D	11-02-1999
		EP 0664054 A	26-07-1995
		EP 0887873 A	30-12-1998
		ES 2124741 T	16-02-1999
		JP 7500943 T	26-01-1995
		US 5368961 A	29-11-1994
		WO 9305540 A	18-03-1993
		US 5045086 A	03-09-1991
US 5599641 A	04-02-1997	AU 2317695 A	16-11-1995
		WO 9529507 A	02-11-1995